Geophysical Research Abstracts,
Vol. 11, EGU2009-1879, 2009
EGU General Assembly 2009
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Multi-Scale Analysis of Teleconnection Indices: Climate Noise and Nonlinear Trend Analysis

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The multi-scale nature and climate noise properties of teleconnection indices are examined by using the Empirical Mode Decomposition (EMD) procedure. The EMD procedure allows for the analysis of non-stationary time series to extract physically meaningful intrinsic mode functions (IMF) and nonlinear trends. The climatologically relevant monthly mean teleconnection indices of the North Atlantic Oscillation (NAO), the North Pacific index (NP) and the Southern Annular Mode (SAM) are analyzed.

The significance of IMFs and trends are tested against the null hypothesis of climate noise. The analysis of surrogate monthly mean time series from a red noise process shows that the EMD procedure is effectively a dyadic filter bank and the IMFs (except the first IMF) are nearly Gaussian distributed. The distribution of the variance contained in IMFs of an ensemble of AR(1) simulations is nearly χ^2 distributed. To test the statistical significance of the IMFs of the teleconnection indices and their nonlinear trends we utilize an ensemble of corresponding monthly averaged AR(1) processes, which we refer to as climate noise. Our results indicate that most of the interannual and decadal variability of the analysed teleconnection indices cannot be distinguished from climate noise. The NP and SAM indices have significant nonlinear trends, while the NAO has no significant trend when tested against a climate noise hypothesis.